

NAVSEA 2 – Cognitive testing at HIGH workload levels Improves Performance Discrimination on the Multi-attribute task battery-II



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NAVSEA Hypercapnea Study

- **Purpose:**
 1. Define the human physiology of CO₂ elimination at increased depths and gas densities
 2. Qualify the effects of CO₂ on nitrogen narcosis
 3. Test and quantify the interaction between the partial pressures of CO₂, O₂ and N₂ on cognitive performance in order to construct an algorithm to compute “equivalent narcotic depth”
- IRB approved
- **Phase 1: software and procedure development**

Multi-Attribute Task Battery (MATB-II)

- Designed by NASA and used by Navy
- Computer-based task battery developed to simulate various aspects of flight
- Designed to evaluate operator performance and workload



File

Help

SYSTEM MONITORING

TRACKING

SCHEDULING

F5

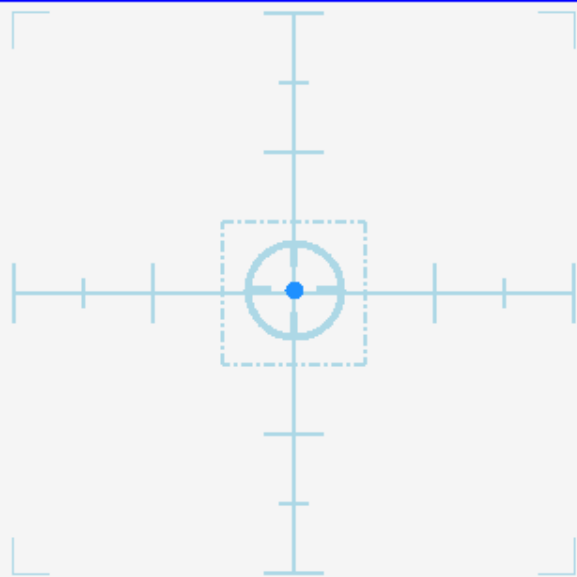
F6

F1

F2

F3

F4



AUTO ON

0

2

4

6

8

min

C

T

Elapsed Time

00:00:00

COMMUNICATIONS

RESOURCE MANAGEMENT

PUMP STATUS

Call Sign

NASA504

NAV1

112 .500

NAV2

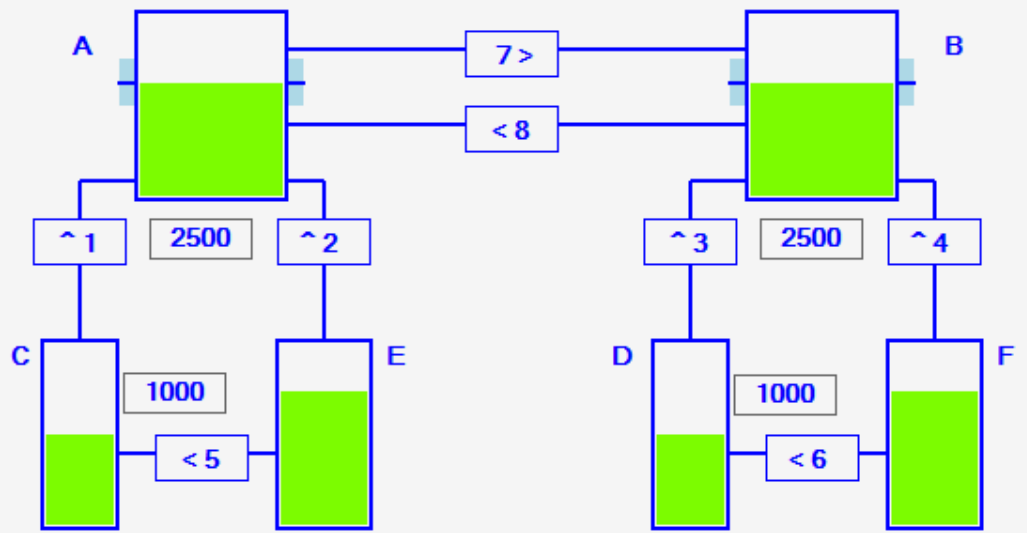
112 .500

COM1

126 .500

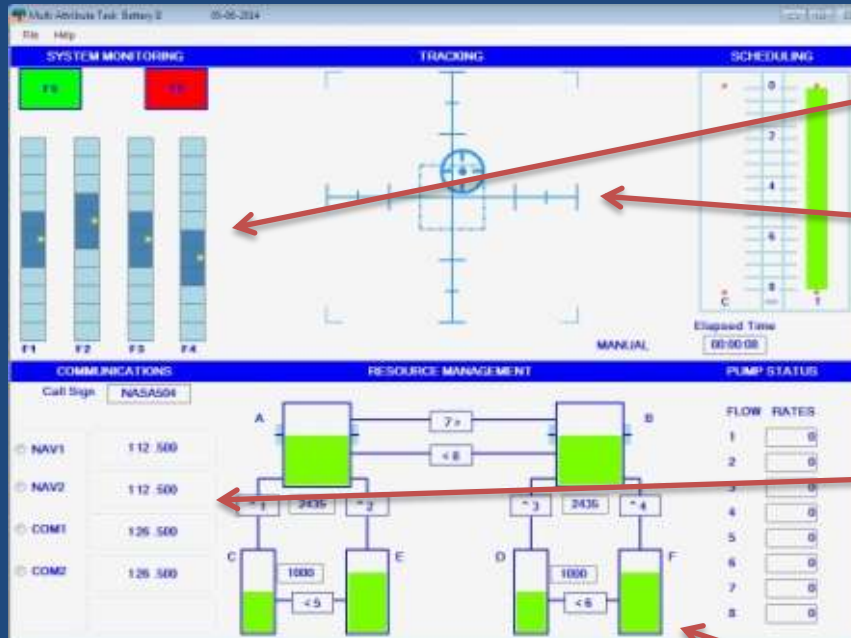
COM2

126 .500



FLOW RATES	
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0

MATB 2



System monitoring task
(Sysmon)

Tracking task (Track)

Communication task
(Comm)

Resource management task
(Resmon)



radio frequency 4 position
switch

up / down large numbers
side to side decimal numbers

trigger: enters radio
selection

selects which
radio

pump 7 up, 8 down
(return to center point)

pump 1

pump 6



- Pilot phase showed that tracking at low workloads was not consistently affected by elevated PCO₂ or PN₂...Performance ceiling effects?
- Evaluated High vs Low workload to test if High workload might counteract the ceiling effect
- Specific hypothesis:
 1. During High workloads, performance decreases in all areas compared to low workloads
 2. Practice mitigates this effect

HIGH (tracking,
sysmon, comm,
resmon)

N=4

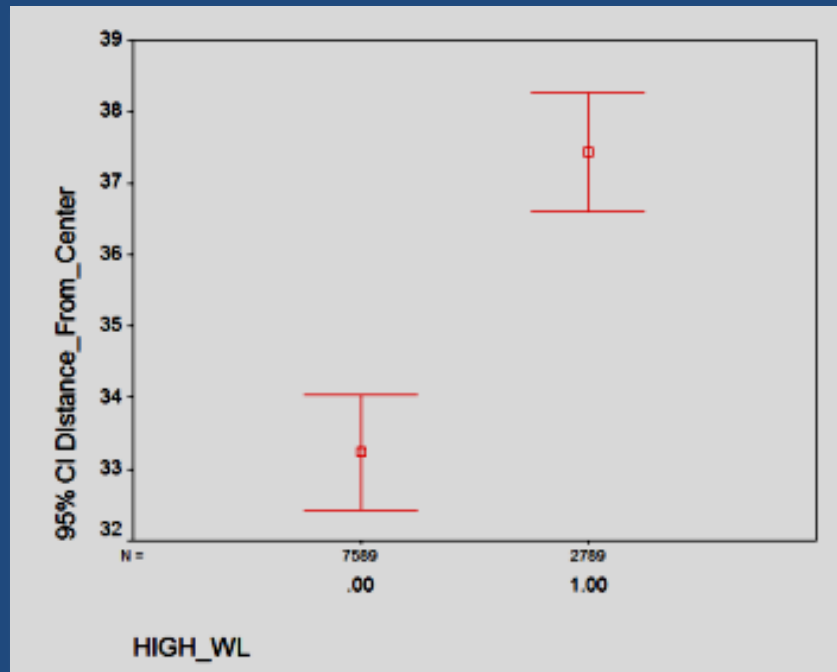
LOW (tracking, sysmon)

N= 6

- Surface conditions only

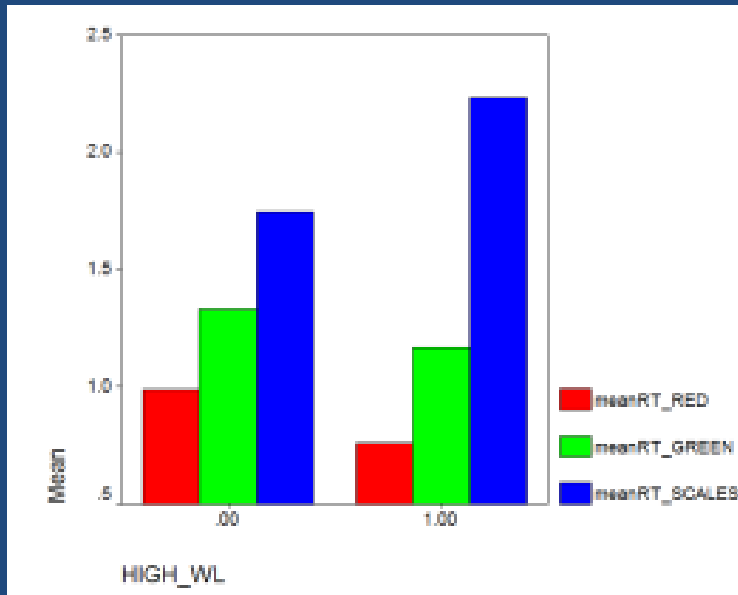


Results



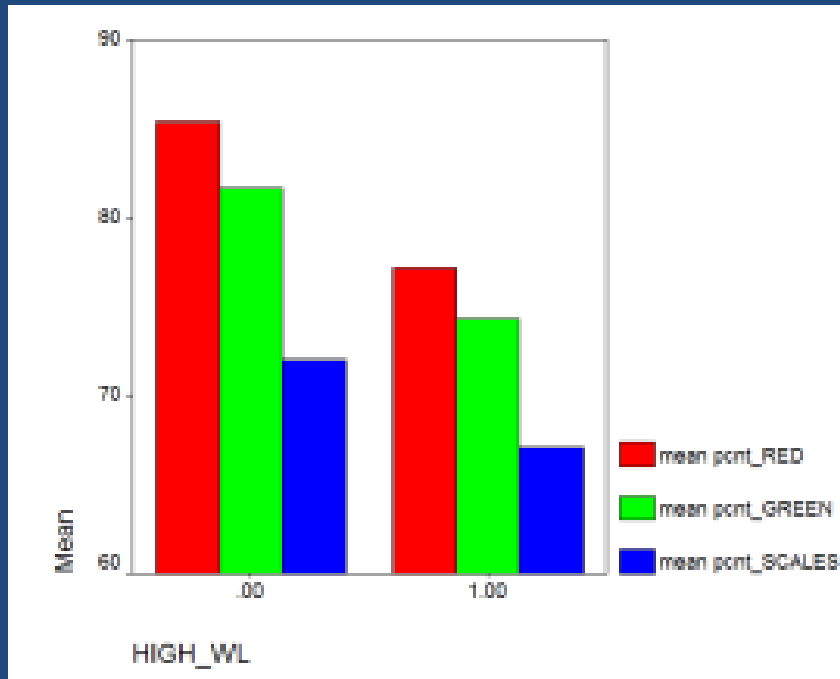
High vs low workload tracking was significantly impaired by an increase in the second-by-second mean pixel distance from the target from **33.23** (95% CI 32.5-33.9) pixels (LOW) to **37.43** (95% CI 36.2-38.6) pixels (HIGH)

Results



Reaction time of Sysmon tasks for the more difficult “scale” elements of Sysmon was significantly longer in **high (2.12)** versus **low (1.75)** workload scenarios

Results



Accuracy was not significantly different at high versus low workloads



Conclusions

- High workload testing is required to unmask the narcotic gas impairment threshold for the Tracking task
- High workload testing may help identify scenarios where skilled subjects develop strategies to mask overall cognitive impairment by selectively sacrificing one task in order to maintain competence in others
- Further pilot testing at high workloads under conditions of elevated PO₂, PN₂ and PCO₂ is planned



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